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DEVELOPMENT OF A SUPPORTED AIRBAG EJECTION RESTRAINT (SABER) FOR WINDBLAST PROTECTION

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This is a preliminary investigation to develop an airbag mounted on an ejection seat. The airbag is designed to deploy during an emergency ejection and may provide both prepositioning of the aircrewman and windblast protection for his upper torso.

The airbag is tightly packed on a flexible steel strap which is mounted at the aircrewman's shoulder level. Quick disconnect fittings on either side permit the crewman to enter the seat; they also disconnect the entire system upon seat/man separation.

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SUMMARY

This is a preliminary development of a Supported Airbag Ejection Restraint (SABER) designed to protect an ejecting aircrewman from limb flail due to high windblast pressures.

The system is designed to be retrofittable on existing ejection seats. It consists of a flexible thin steel strap mounted as a semicircular hoop at the aircrewman's shoulder level. An airbag is rolled up on the strap and held in place with a cover. Air hoses lead from the bag to quick disconnect fittings on either side of the strap. Compressed air bottles supply air to remove the cover and fill the airbag. At the instant of seat/man separation the quick disconnect fittings separate the entire system from in front of the ejecting aircrewman.

This preliminary design proves the feasibility of mounting an airbag in a small container to minimize interference with aircrewman operations. Additional design and testing is required to: further simplify the system; determine if it is acceptable to aircrewmen; and make it structurally capable of withstanding high Q airloads.

INTRODUCTION

Navy air combat escape and survival data collected during the Southeast Asian conflict (reference 1) indicated that many aircrewmen received severe limb flail injury during high-speed ejection. This has pointed out the need for some device to protect aircrewmen from high Q forces. NAVAIR responded to this problem by first having a study made of the forces involved and the possible solutions (reference 2). The Naval Air Development Center (NAVAIRDEVCEN) then contracted the Stencel Aero Engineering Corporation to develop a prototype passive, seat-mounted, limb retention system (reference 3). This system was fabricated and is presently being evaluated; however, it was originally designed for installation on the Maximum Performance Ejection Seat (MPES). Even if this design proves successful it will probably not be retrofittable on operational ejection seats because of space requirements.

This SABER development was undertaken to provide a retrofittable design that incorporates several additional functions other than high Q protection. One of these additional functions is to minimize the displacement of an aircrewman when he is thrown forward during a flat spin. Because aircrewmen want upper torso mobility during air combat maneuvers they often leave the inertia reel unlocked. If the aircraft departs controlled flight during a tight turn it can gradually develop yaw rates which subject the aircrewman to a centripetal acceleration in excess of -6 G_x. Since the inertia reel was designed to respond to a strap velocity rather than aircraft acceleration, it permits the aircrewman to be gradually pressed forward without ever automatically locking the inertia reel. Several aircraft have been lost because the pilot was thrown so far forward that he could not regain control of the aircraft. To make matters worse, the aircrewman is often too far forward to actuate his ejection seat. The SABER (undeployed) prevents this from happening since it will only permit

the aircrewman about 15 centimeters of forward motion, yet it is flexible enough not to impede his normal activities.

Another function which the SABER can perform is the prepositioning and support of the aircrewman prior to ejection. It could eliminate the need for an inertia reel retractor, a lap belt retractor, and a crewman neck support device. Also, no existing restraint harness or device provides buckling protection of the spinal column. This could be made available with a properly designed airbag.

High Q protection for the aircrewman is expected from two features of the bag: first, it can entrap the aircrewman's arms, head, and torso; secondly, it can divert the airflow more smoothly around the aircrewman and possible reduce some of the buffeting.

Because of its location a device such as SABER is a rather risky venture as far as pilot acceptance. Nevertheless, it was felt that if such a system could be designed simply and small enough, and if it could provide so many different functions, then it might be tolerated by aircrewmen. It should be noted that there is very little available space on which to mount a retrofittable high Q protection system. Future escape systems *must be initially designed* to incorporate this type protection for the aircrewmen.

DISCUSSION

1. SUPPORT ASSEMBLY

The first prototype MARK I support for the airbag (figures 1, 2 and 3) was designed to provide the following features:

a. Adjustable positioning of the bag both in the vertical (z) and horizontal (x) directions.

b. The restraint bands around the airbag must be located all along the bag and attach securely to both sides of the ejection seat. This implies that some sort of tracks be provided and that a design be developed to engage and disengage all of the sliding bands in the track to allow crewman ingress and egress from the seat.

c. The entire system must be disconnected upon emergency egress and at seat/man separation after ejection.

Considerable time and effort were expended to provide feature b. Initial tests with the first airbag indicated that it was not necessary to attach the bag all along the edge of the ejection seat using sliding bands.

A second prototype MARK 2 bag support was then developed such that the bag restraint bands were anchored to only two points on either side of the seat. When the bag deployed, the bands would fan out from either attachment point. The bag support structure was made of a stainless steel strap .032 x

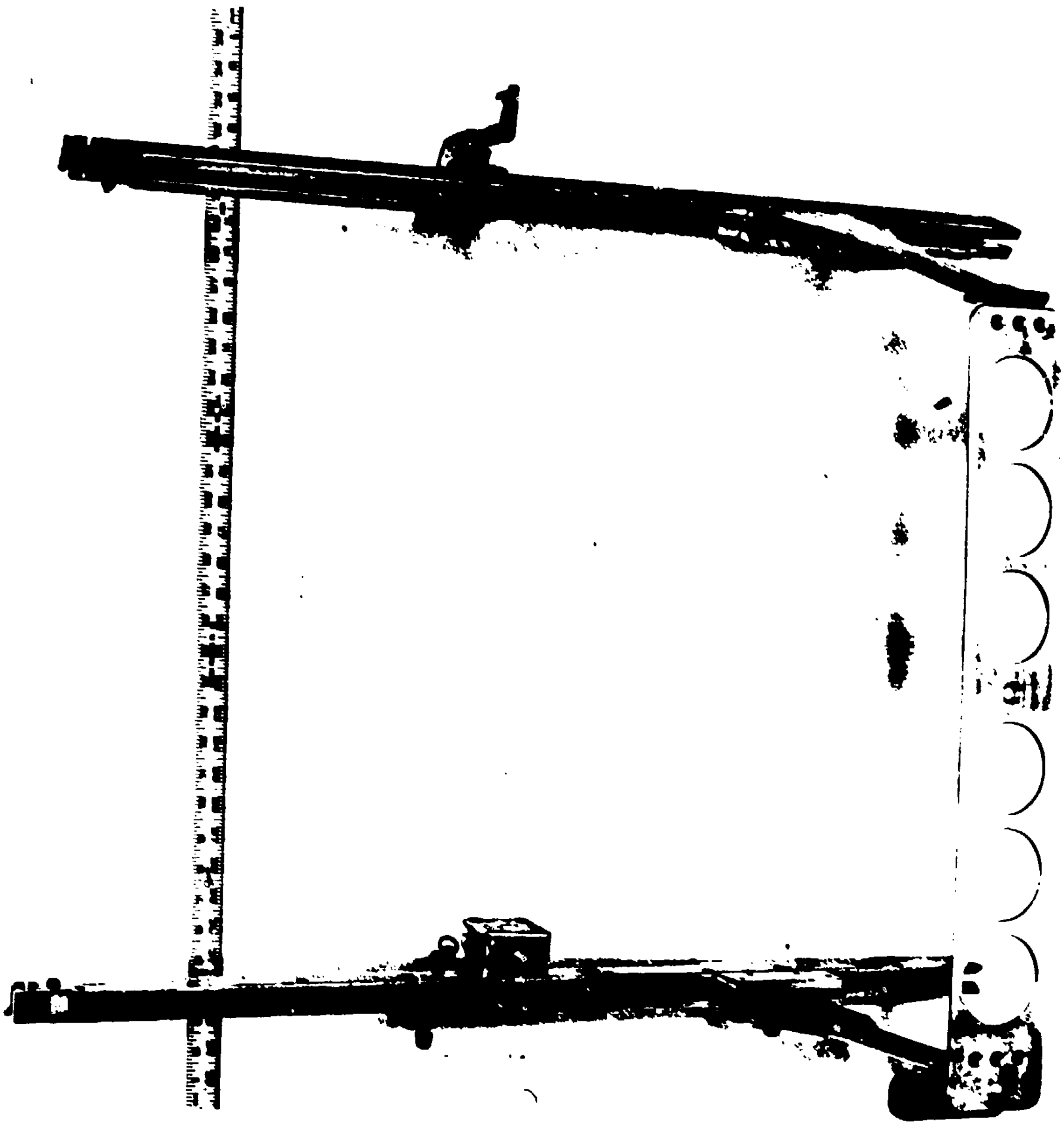


Figure 1 - MARK I Support, Assembled

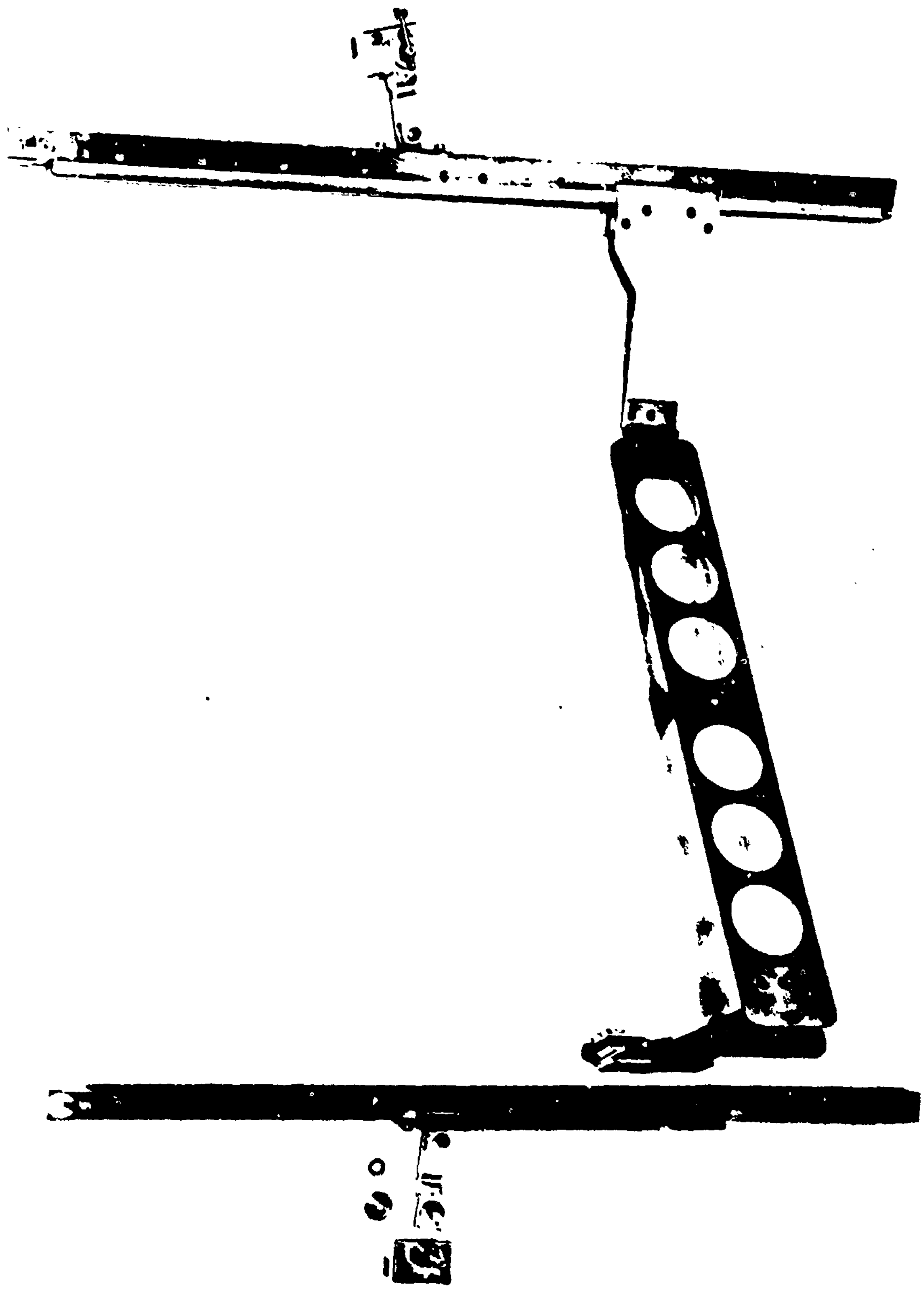


Figure 2 - MARK I Support, Disconnected From Left Track

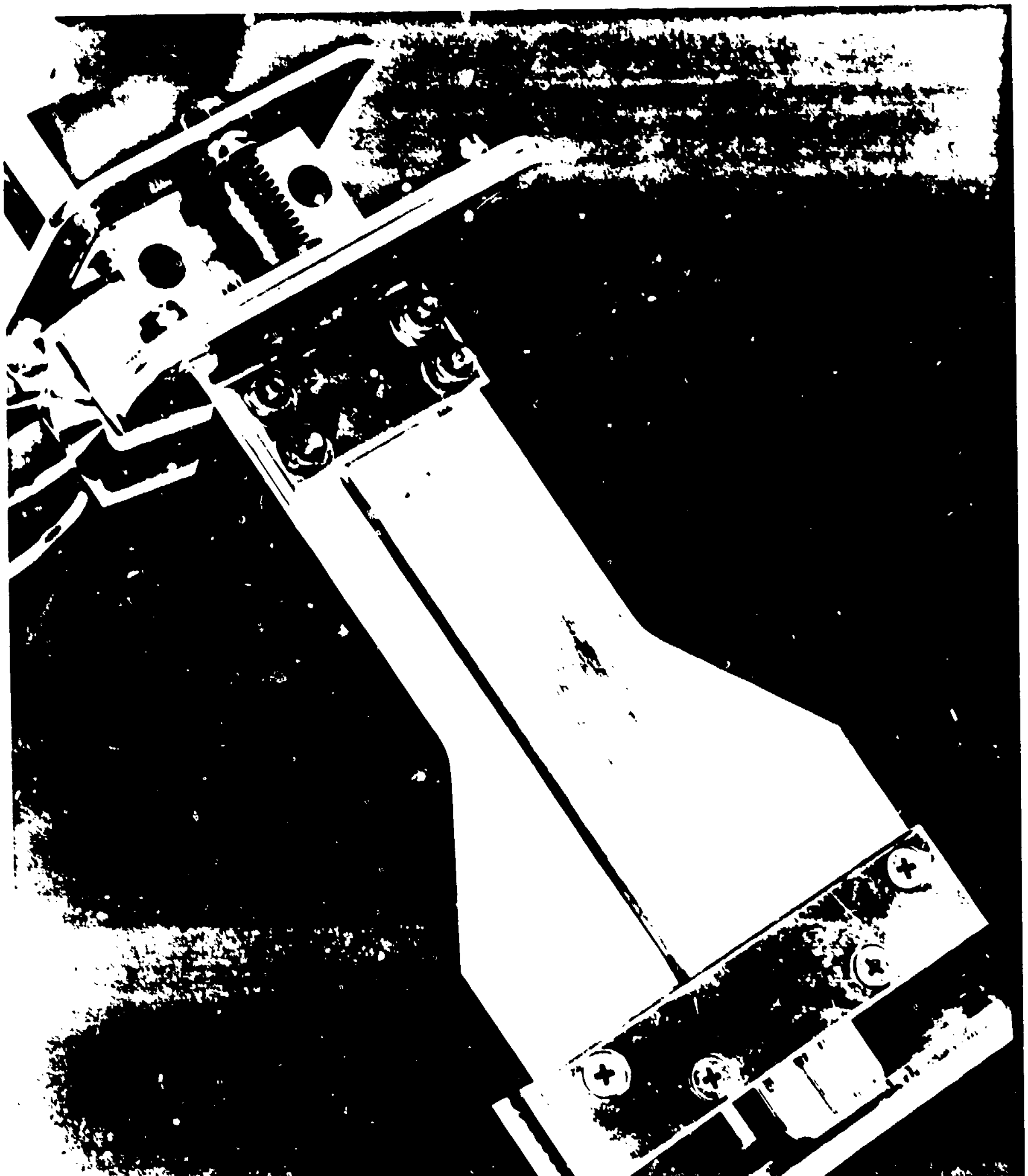


Figure 3 - MARK I Disconnect Tang

1.25 x 43.0 inches (figure 6, 7 and 8). Air hose brackets were provided on either end. Male quick disconnect fittings were attached to both bag filler hoses; the female quick disconnects were mounted on the ejection seat. The airbag was rolled up and covered with a tight-fitting cloth closed with a series of grommets and nylon loops. When locking pins are released by small pistons at both sides of the cover, the interlocking nylon loops are free to allow the cover to open as the airbag expands.

2. AIRBAG

Three prototype bags were designed and fabricated. The first bag (figure 4) had a simple rectangular shape. Several tunnel loops were glued to the cover to hold the bag restraint cables. The second bag (figure 5) was made with loop bands all around its perimeter for the purpose of exploring various locations for the bag restraint straps. The third bag (figures 6 and 7) had only three restraint straps, and it was designed to be as close as possible to an ideal size to cover the 95 percentile aircrewman.

Several trials were made to determine what portion of the straps would be glued to the bag. The number of straps, their location around the bag, how they attach, and their length are all important factors which determine the shape of the bag and how it protects the aircrewman.

Because all of the airbags tested had no internal supports they behaved very much like a rubber balloon; if the bag restraint straps were tight above the main support band, then the bag would bulge out at the bottom. This effect can be seen in figure 12. Future bags will be designed with internal support so that the final shape will not be a function of the external straps and there will not be bulges. Internal support will also permit the use of higher airbag pressures without injuring the aircrewman.

Figures 7, 8, 9, 10, 11 and 12 show various views of the SABER system, MARK 2 with a live subject seated in an ESCAPAC ejection seat.

Initial tests indicate that the SABER doesn't seem to interfere much with either aircrewman visibility or function, but additional tests must be conducted.

3. WHAT HAS BEEN ACCOMPLISHED

The design has been simplified and packaged as small as possible.

4. FUTURE DEVELOPMENT

It is feasible to provide the ejection seat with a supported airbag ejection restraint which could handle the high Q forces; however, it would be imprudent to proceed with this development if the location of the airbag interferes with aircrewman function. Therefore, the next step in the program will be an evaluation for pilot acceptability. If the concept tests favorably, then further engineering development of SABER can proceed as indicated in section 5.

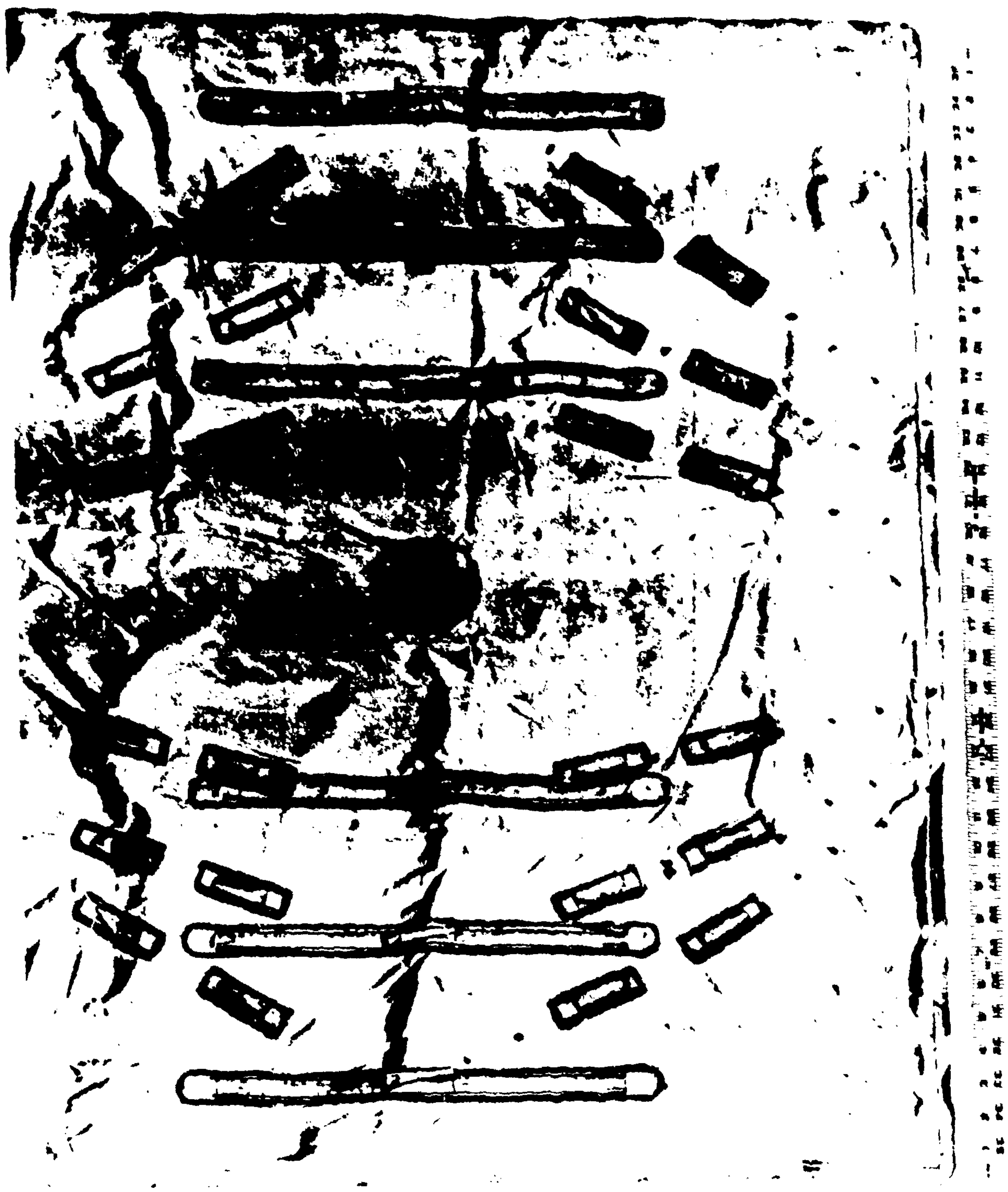


Figure 4 - Airbag No. 1

Figure 5 - Airbag No. 2

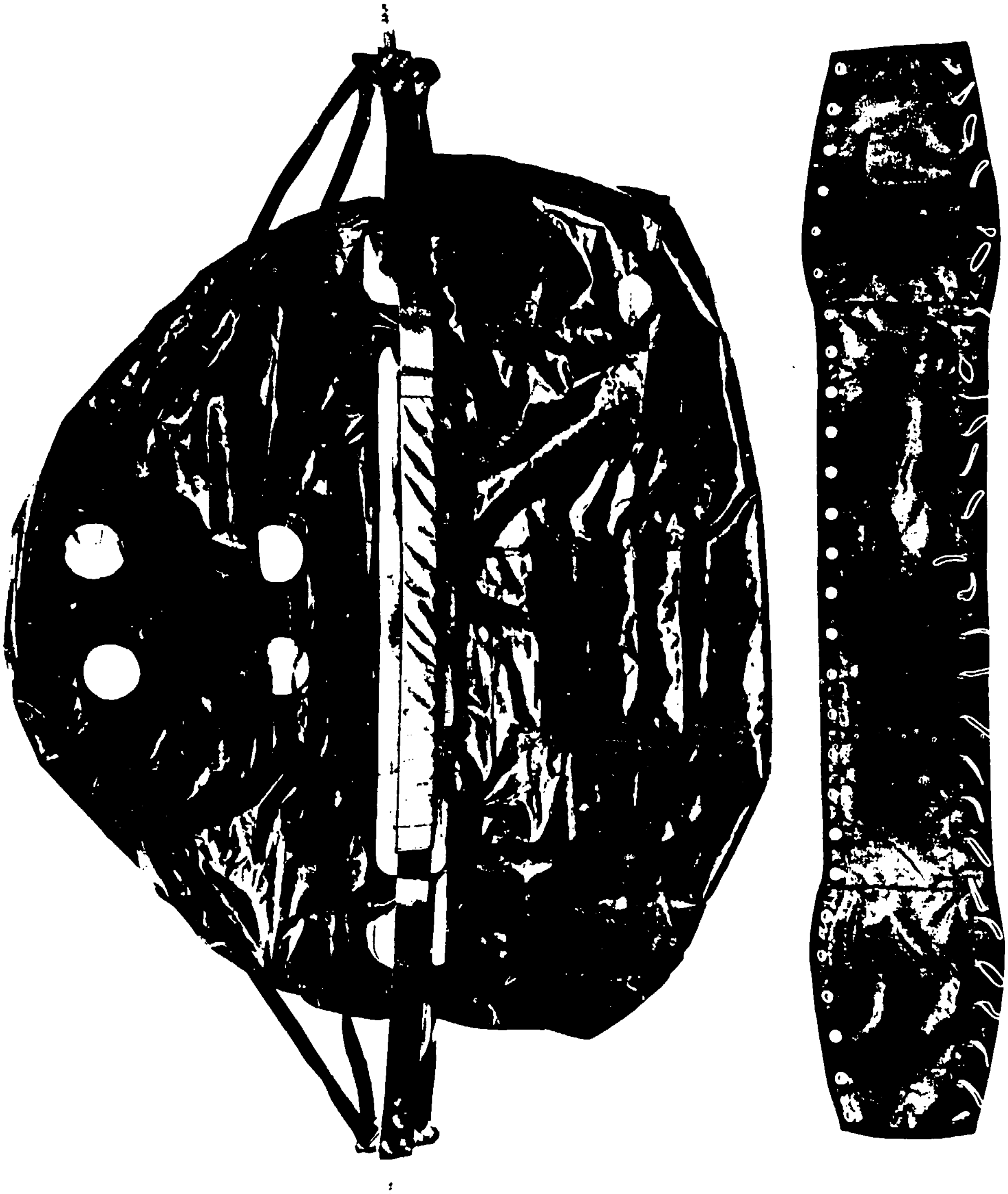


Figure 6 - Airbag No. 3 With Bag Cover And MARK 2 Support

Figure 7 - Airbag No. 3 Inflated On Seat

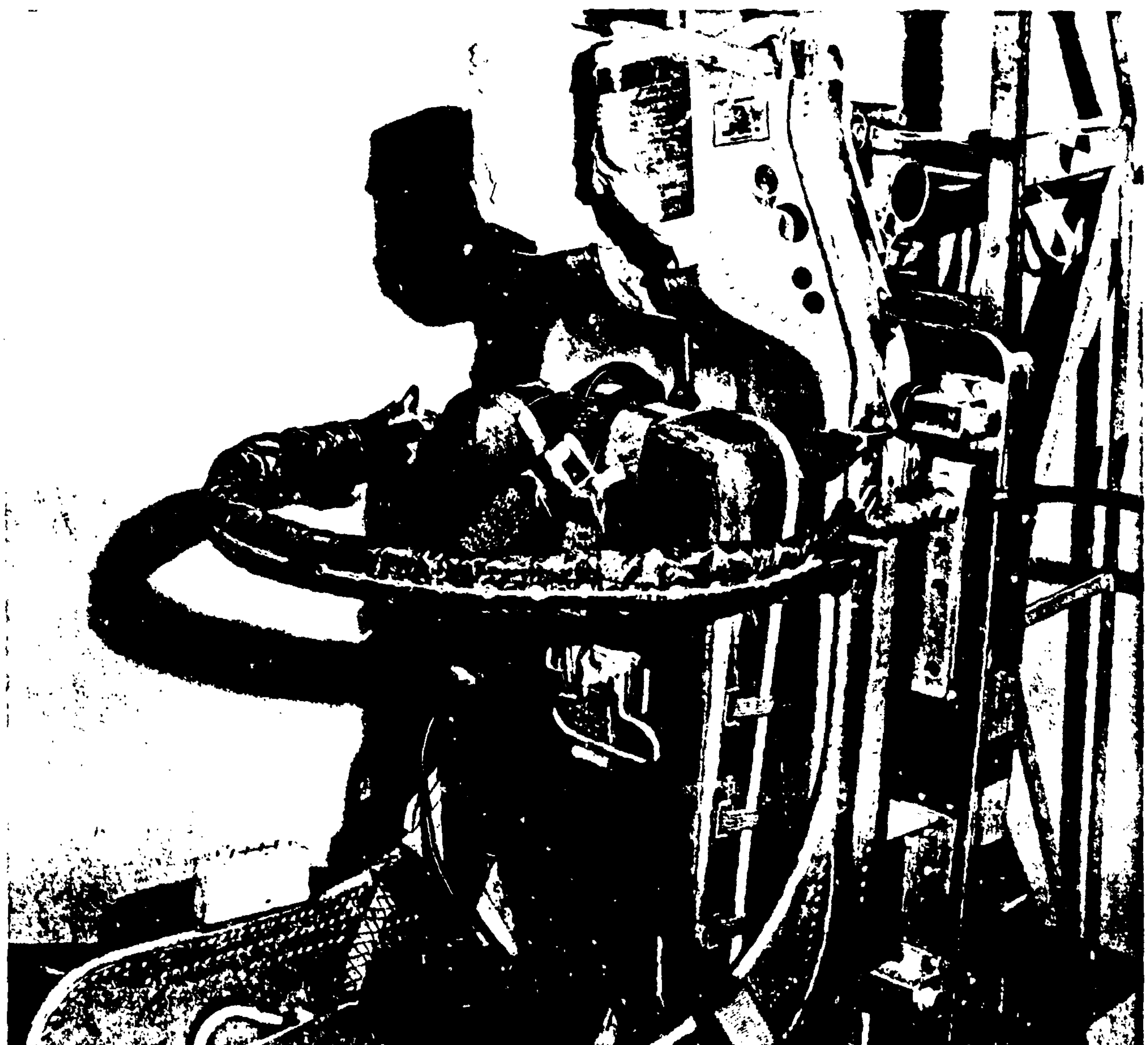


Figure 8 - SABER MARK 2 On ESCAPAC Seat

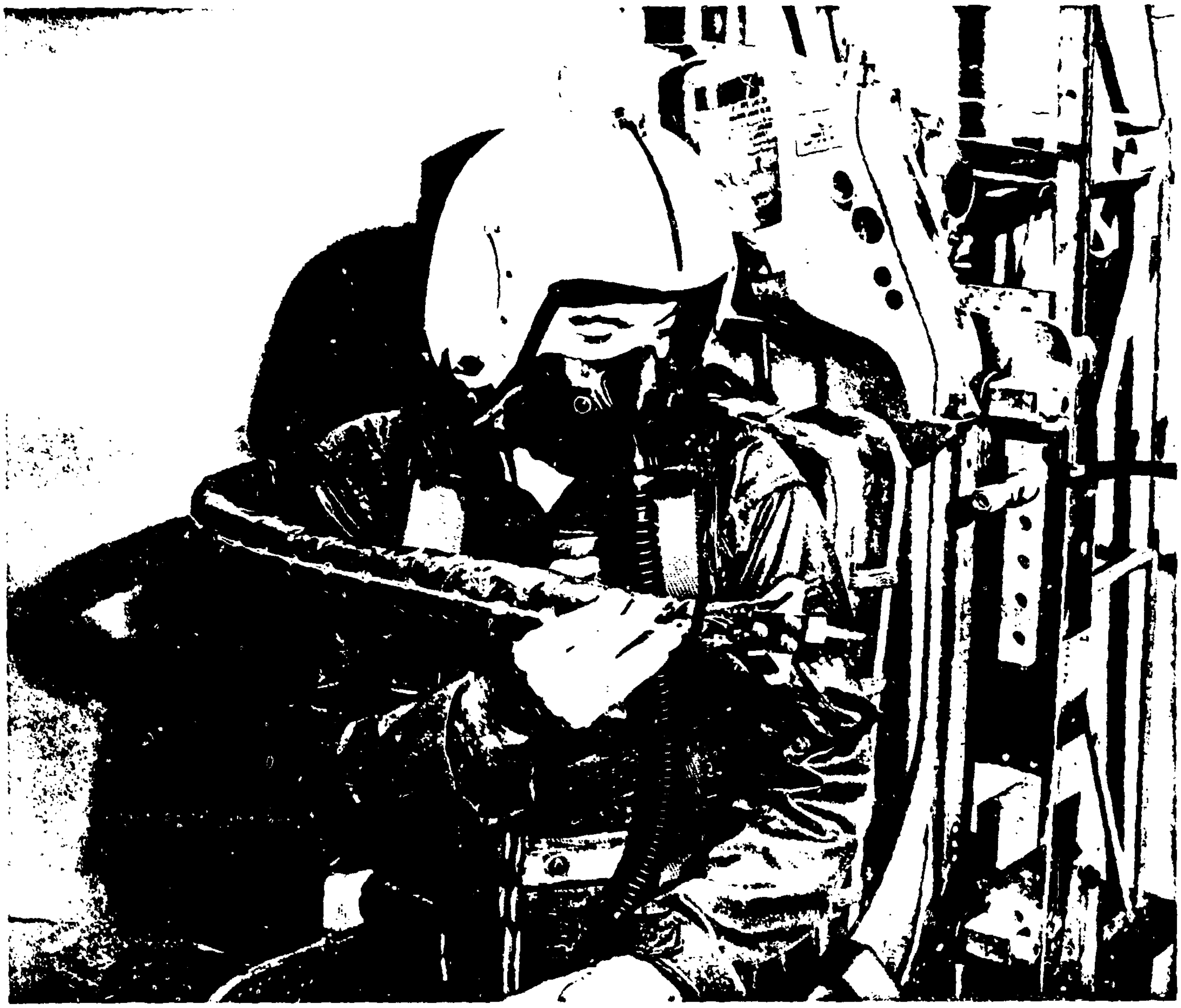


Figure 9 - Aircrewman Getting Into The Ejection Seat

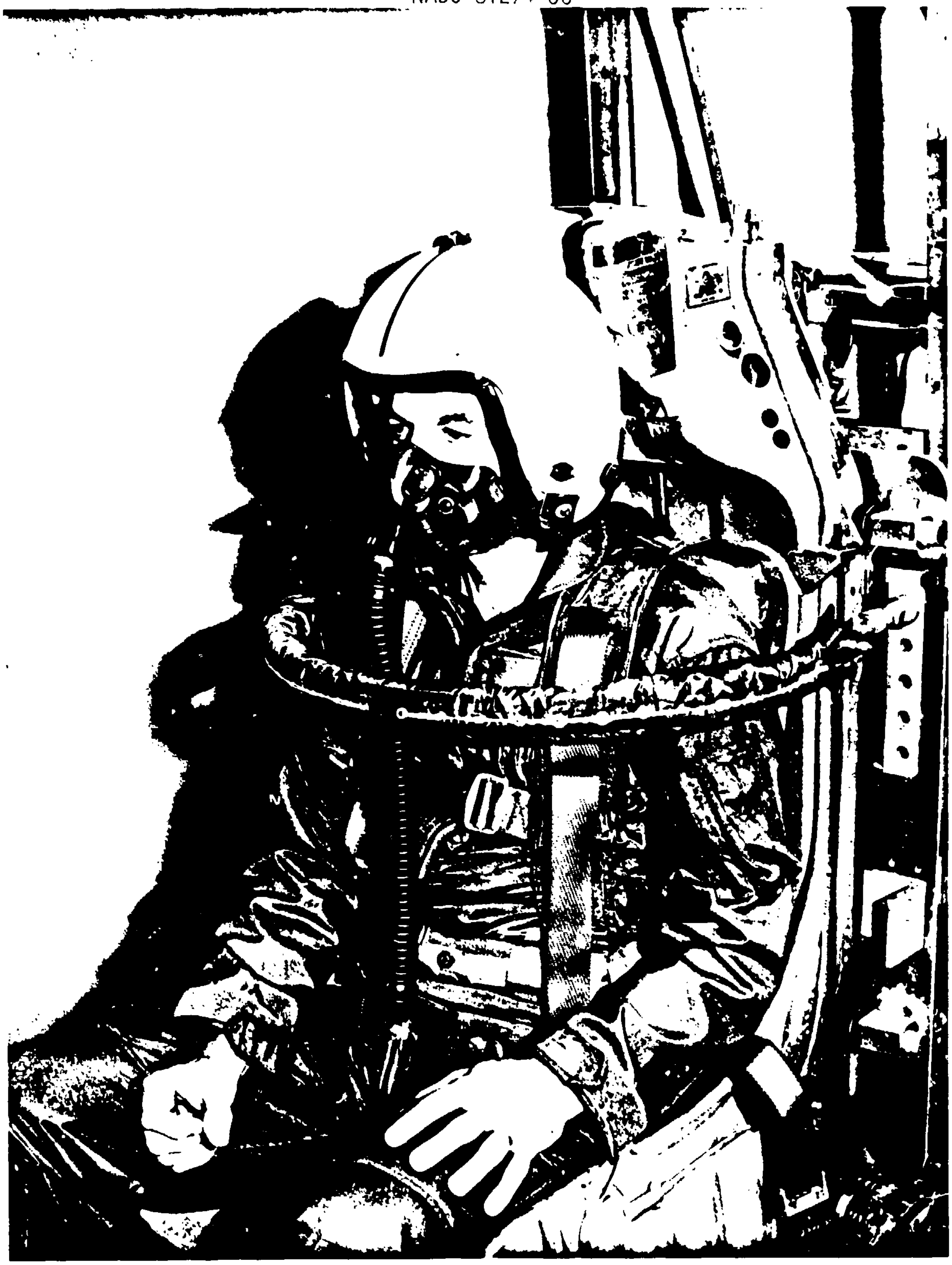


Figure 10 - SABER MARK 2 With Aircrewman In The Seat

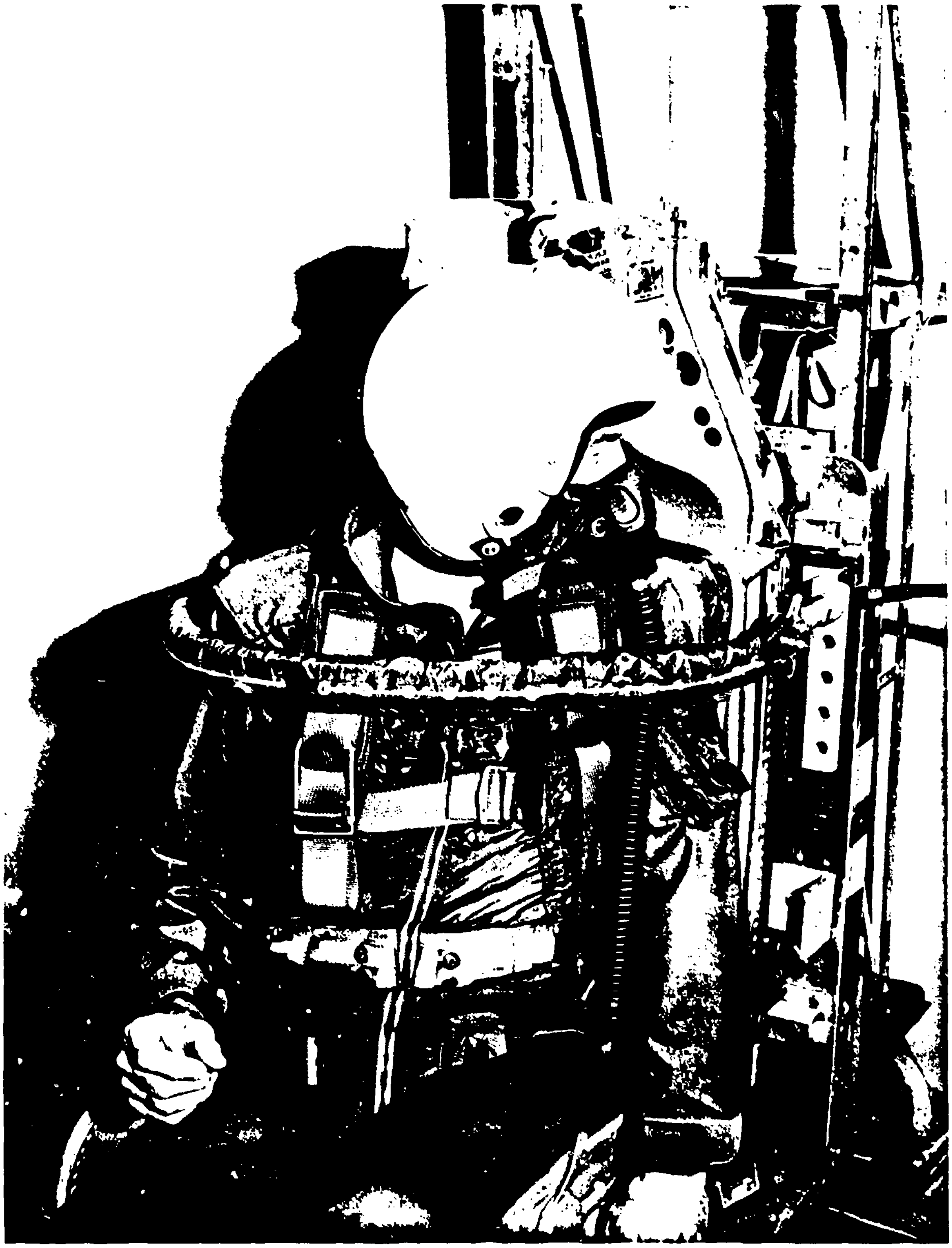


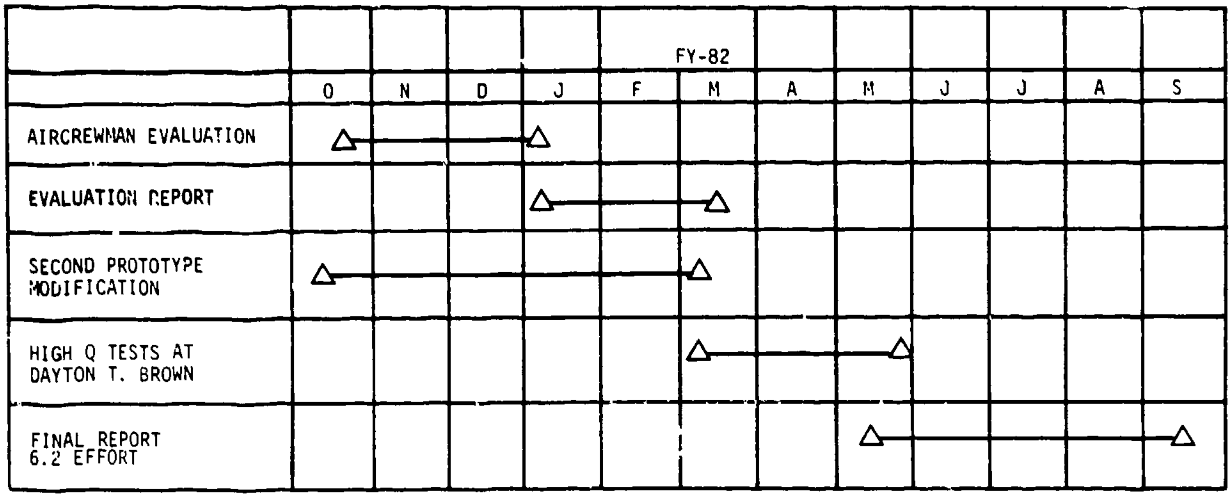
Figure 11 - Aircrewman Turning To Look Aft (SABER MARK 2)

Figure 12 - Airbag No. 3 Inflated With Crewman In Seat

The next prototype airbag will probably be designed with an internally braced Kevlar *Contour Fabric* which should be able to withstand the high Q forces. Also, its shape will be less dependent on the support straps location.

If the SABER system proves worthwhile it will be possible to redesign the aircrewman's life vest so that it will be more comfortable. Because the SABER will cover the crewman from the windblast, the life vest need not be folded into a protective case. It can be worn opened up similar to the old "Mae West." The vest could be zippered onto the flight suit around its perimeter. This would permit removal of the bladders for repair or for cleaning the suit. The zippers would eliminate the need for straps around the crewman which restrict natural ventilation.

5. SABER MILESTONES FOR FISCAL 1982



RECOMMENDATIONS

1. The SABER system should be thoroughly evaluated for possible interference with aircrewman mission.

2. If SABER offers little or no interference to aircrewman mission it should be designed and fabricated to withstand high Q forces, then tested.

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